APPENDIX D

Natural Resources

This appendix includes additional natural resources information that is utilized in the RP/EIS. Several of the restoration alternatives rely on the ability of certain habitat types to function in support of injured natural resources. Based on the Estuarine Habitat Assessment Protocol (EHAP), certain habitat types should function in support of predictable species assemblages. The species listed in Tables D-1 to D-8 are known to be dependent on the particular habitat with which they are associated. The list of species in each table is representative rather than inclusive; more detailed information on the most common species currently found in the primary and expanded study areas is provided in section 2.0 of the EIS. However, the feeding mode, reproductive habits, and behavior of species that are not listed in Tables D-1 to D-8 should be represented by at least one sympatric species that is on one or more of the lists. The EHAP represents the most comprehensive database of species-habitat linkages in our region.

Table D-9 provides information on recent hatchery releases of juvenile salmonids. Table D-10 is a list of mammals potentially occurring in the study area. Table D-11 is a list of substances of concern. Figures D-1 to D-4 provide current information on salmonid usage in the Basin, Figure D-5 provides current information on sensitive fish and avian distribution in the Bay and Basin.

Species Assemblages:

Table D-1. Mudflat [(a)] Species Assemblage in the Primary Study Area.

Fishes and Macroinvertebrates	Avifauna	Mammals
Dungeness crab	Canada goose	Pacific harbor seal
English sole (juvenile)	Common goldeneye	Raccoon
Pacific staghorn sculpin	Common snipe	
Starry flounder	Dunlin	
Chum salmon	Great blue heron	
	Greater yellowlegs	
	Least sandpiper	
	Short-billed dowitcher	
	Spotted sandpiper	
	Western sandpiper	

[(a)] As defined by Cowardin et al. (1979), mudflats are intertidal shores not vegetated by macrophytes and with unconsolidated sediment particles smaller than stones, predominantly silt (0.0625 to 0.00391 mm particle diameter) and clay (0.00391 to 0.00024 mm); the substrate usually has high organic content, and anaerobic conditions often exist below the surface.

Table D-2. Sandflat[a] Species Assemblage in the Primary Study Area.

Fishes and Macroinvertebrates	Avifauna	Mammals
Dungeness crab	Common goldeneye	
Pacific sanddab	Common snipe	
Pacific staghorn sculpin	Dunlin	
Sand sole	Great blue heron	
Speckled sanddab	Greater yellowlegs	
	Horned grebe	
	Least sandpiper	
	Spotted sandpiper	

[a] As defined by Cowardin et al. (1979), sandflats are intertidal shores that are not vegetated by macrophytes and have unconsolidated sediment in which particles smaller than stones are predominantly sand (2.0 to 0.074 mm).

Table D-3. Gravel-cobble[a] Species Assemblage in the Primary Study Area.

Fishes and Macroinvertebrates	Avifauna	Mammals
Buffalo sculpin	Buffelhead	Raccoon
Coho salmon (juvenile)	Double-crested cormorant	
Copper rockfish	Horned grebe	
Cutthroat trout	Least sandpiper	
Dolly varden trout	Mew gull	
Great sculpin	Spotted sandpiper	
Pacific tomcod	Western grebe	
Padded sculpin		
Pile perch		
River lamprey		
Rock crab		
Starry flounder		
Surf smelt		
Whitespotted greenling		
Dungeness crab		

[a] As defined by Cowardin et al. (1979), gravel/cobble habitats are intertidal shores which have substrates composed of a mixture of cobble (256 to 76 mm) and gravel (76.2 to 4.76 mm).

Table D-4. Eelgrass Species Assemblage in the Primary Study Area.

Fishes and Macroinvertebrates	Avifauna	Mammals
Bay pipefish	Black brant	Pacific harbor seal
Chum salmon (fry)	Buffelhead	
Pink salmon (fry)	Canada goose	
Crescent gunnel	Common snipe	
Dungeness crab	Glacous-winged gull	
Kelp perch	Great blue heron	
Penpoint gunnel	Greater yellowlegs	
Shiner perch	Least sandpiper	
Snake prickleback	Osprey	
Striped seaperch	Spotted sandpiper	
Tube-snout		

Table D-5. Riparian Species Assemblage in the Primary and Expanded Study Area.

Fishes and Macroinvertebrates	Avifauna	Mammals
Cutthroat trout	Great horned owl	River otter
Rainbow trout	Red-tailed hawk	Raccoon
Chum salmon	Common crow	Coyote
Coho salmon	Belted kingfisher	Vagrant shrew
Chinook salmon	Barn swallow	Mink
	Tree swallow	Beaver
	Violet-green swallow	Little brown bat
	Great blue heron	
	Wood duck	
	Bald eagle	

Table D-6. Emergent Marsh[a] Species Assemblage in the Primary and Expanded Study Areas.

Fishes and Macroinvertebrates	Avifauna	Mammals
Chinook salmon (fry)	American coot	Muskrat
Chum salmon (fry)	American goldfinch	Pacific harbor seal
Cutthroat trout	American widgeon	Raccoon
Pacific staghorn sculpin	Black brant	Townsend vole
Prickly sculpin	Buffelhead	
Three-spine stickleback	Canada goose	
	Common goldeneye	
	Common snipe	
	Dark-eyed junco	
	Gadwall	
	Great blue heron	
	Greater yellowlegs	
	Green-winged teal	
	Killdeer	
	Least sandpiper	
	Mallard	
	Merlin	
	Northern oriole	
	Osprey	
	Redtail hawk	
	Redwing blackbird	
	Savannah sparrow	
	Short-billed dowitcher	
	Song sparrow	
	Spotted sandpiper	

[a] Emergent marshes occur as intertidal shores of unconsolidated substrate that are colonized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens (Cowardin et al., 1979).

Table D-7. Palustrine Freshwater Species Assemblage in the Expanded Study Area.

Fishes and Macroinvertebrates	Avifauna	Mammals
	Great blue heron	Muskrat
	Killdeer	Beaver
	Red-winged blackbird	Raccoon
	Common yellowthroat	Northern water shrew
	Long-billed marsh wren	Townsend vole
	Common snipe	Opossum
	Pintail	Deer mouse
	American widgeon	Vagrant shrew
	Green-winged teal	Spotted skunk
	Mallard	
	American coot	
	Song sparrow	
	Marsh hawk	
	Red-tailed hawk	
	Common crow	
	Barn swallow	
	Tree swallow	
	Violet-green swallow	
	Least sandpiper	
	Pectoral sandpiper	
	Green-backed heron	
	Wood duck	

Table D-8. Subtidal Species Assemblage in the Primary Study Area.

Fishes and Macroinvertebrates	Avifauna	Mammals
Starry flounder	Western grebe	Pacific harbor seal
Pacific staghorn sculpin	White-winged scoter	Sea-lion
Yellow perch	Double-crested cormorant	Harbor porpoise
Pacific herring	Canvasback	
Shiner perch	Surf scoter	
Longnose skate	American coot	
Spiny dogfish	Common goldeneye	
Green sturgeon	Bufflehead	
Speckled sanddab	Red-breasted merganser	
Buffalo sculpin	Greater scaup	
Chinook salmon (juvenile)	Horned grebe	
English sole	Red-necked grebe	
Cutthroat trout	Common loon	
Arrow goby	Rhinoceros auklet	
Dungeness crab		
Pacific sand lance		

Table D-9. **Hatchery Releases of Juvenile Salmonids to the Puyallup River Basin in 1992 (CB Trustees, 1995)**

LIFE STAGE PLANTED	SPECIES				
	CHINOOK STATE/TRIBE	CHUM STATE/TRIBE	PINK STATE/TRIBE	COHO STATE/TRIBE	STEELHEAD STATE/TRIBE
Eggs	0/0	0/0	0/0	15,000/0	0/0
Fry (850–1,700 fish/pound)	21,000/0	0/426,813	10,900/0	1,885,700/6,728	0/0
Fingerling (120–600 fish/pound)	13,591/101,5824	0/0	0/0	694,446/364,004	0/0
Yearling (16–17 fish/pound)	0/38,386	0/0	0/0	1,249,300/0	0/0
Smolts (5 fish/pound)	0/0	0/0	0/0	0/0	107,633/ 15,975

Table D-10. List of Mammals Potentially Occurring in the Study Area (CB Trustees, 1995).

COMMON NAME	SPECIES	STATUS	COMMENTS
ORDER MARSUPIALIA			
Common Opossum	*Didelphis marsupialia*	Resident	Was introduced into northwestern Oregon in 1939 and has spread over most of western Washington.
ORDER INSECTIVORA			
Masked Shrew	*Sorex cinereus*	Upland Resident	Rare in humid coastal areas.
Trowbridge Shrew	*Sorex trowbridgei*	Upland Resident	Resident of Puget Sound lowlands.
Vagrant Shrew	*Sorex vagrans*	Upland Resident	Most common in western Washington.
Shrew-mole	*Neurotrichus gibbsii*	Upland Resident	Occurs in Douglas fir forests.
Townsend Mole	*Scapanus townsendii*	Upland Resident	Resident in the fields and meadows in Douglas fir areas
Pacific Mole	*Scapanus orarius*	Upland Resident	Resident in the deciduous component of Douglas fir forests, and occurs only in woodlands near Commencement Bay.
ORDER CHIROPTERA			
Little Brown Myotis	*Myotis lucifugus*	Migratory Visitor	Most common bat in Puget Sound lowlands, commonly seen in urban areas.
Long-eared Myotis	*Myotis evotis*	Migratory Visitor	
Long-legged Myotis	*Myotis volans*	Migratory Visitor	Also known as the hairy-winged Myotis, occurs in open forest.
Hoary Bay	*Lasiurus cinereus*	Migratory Visitor	
Big Brown Bay	*Eptesicus fuscus*	Migratory Visitor	
Western Big-eared Bat	*Pleucotus townsendii*	Migratory Visitor	Status of this rare species is not known in the Commencement Bay area.
ORDER LANGOMORPHA			
Eastern cottontail	*Sylvagus floridanus*	Introduced	Introduced into many counties in Washington and found in the tideflats.
ORDER RODENTIA			
Mountain Beaver	*Aplodontia rufa*	Upland Resident	Common in humid, coastal woods.
Townsend's Chipmunk	*Eutamius townsendii*	Upland Resident	Common coastal chipmunk.
Eastern Gray Squirrel	*Sciurus carolinensis*	Upland Resident	Introduced in urban areas.
Chickaree	*Tamiasciurus douglasi*	Upland Resident	Strictly associated with Douglas fir forests.
Beaver	*Castor canadensis*	Riparian	Status in the Puyallup River valley is dependant upon small trees for food.
Deer mouse	*Peromyscus maniculatus*	Resident	Common native mouse.
Townsend vole	*Microtus townsendii*	Resident	

Table D-10. List of Mammals Potentially Occurring in the Study Area (continued).

COMMON NAME	SPECIES	STATUS	COMMENTS
Muskrat	*Ondatra zibethica*	Riparian	Status in the Puyallup River valley is dependent upon freshwater ponds with adequate food supply.
Norway Rat	*Rattus norvegicus*	Introduced	
Black Rat	*Rattus rattus*	Introduced Resident	
House mouse	*Mus musculus*	Introduced Resident	
ORDER CARNIVORA			
Raccoon	*Procyon lotor*	Resident	Well established in wooded areas, especially with riparian zones. Suburban pest.
Coyote	*Canus latrans*		Present in many suburban areas as well as in the tideflats open areas.
Red Fox	*Vulpes fulca*	Resident	Seen regularly at Gog-le-hi-te Marsh.
Mink	*Mustela vison*	Riparian	Status of this species of concern along the Puyallup River is dependant upon muskrat and ducks, which are principal prey items in addition to fish.
Long-tailed weasel	*Mustela frenata*		Certainly present along the Puyallup River, but its abundance is unknown.
Ermine	*Mustela erminea*	Upland Resident	Certainly present along the Puyallup River, but its status is unknown. It has been trapped in suburban Bellingham.
Striped skunk	*Mephitis mephitis*	Upland Resident	Present in many suburban areas, and in areas of the tideflats that contain enough cover.
Spotted Skunk	*Spilogale putorius*	Upland Resident	Not as well documented as the striped skunk.
Bobcat	*Lynx rufus*	Upland Resident	This species is an infrequent visitor to suburban areas in the Puget Sound lowlands.
River Otter	*Lutra canadensis*	Riparian and Marine	A resident in Commencement Bay, often seen in salt water. One was seen at Dumas Bay in 1993.
Harbor Seal	*Phoca vitulina*	Marine Resident	Nearest pupping area is Gertrude Island next to McNeil Island, south of the Narrows. The source of seals in Commencement Bay has not been validated.

Table D-10. List of Mammals Potentially Occurring in the Study Area (continued).

COMMON NAME	SPECIES	STATUS	COMMENTS
California Sea Lion	*Zalophus californianus*	Marine Visitor	Juvenile males congregate at river mouths in the Pacific Northwest, causing extensive damage to salmonid runs. The status of sea lions at the mouth of the Puyallup River is unknown.
ORDER ARTIODACTYLA			
Mule Deer	*Odocoileus hemionus*	Upland Resident	The status of this species along the Puyallup River is unknown. There may be a population in Federal Way.
ORDER CETACEA			
Killer Whale	*Orcinus orca*	Marine Visitor	There are no resident pods in central Puget Sound, however, groups of orca are frequently seen off Vashon and Maury. It has been recorded in Commencement Bay.
Harbor Porpoise	*Phocoena phocoena*	Marine Visitor	Has been recorded from Carr Inlet, had a historical presence in Puget Sound.
Dall Porpoise	*Phocoenoides dalli*	Marine Visitor	Seen regularly in central Puget Sound. It is not known if this species calves in Puget Sound.
Gray Whale	*Eschrichtius gibbosus*	Marine Visitor	Since the dramatic recovery of this species, evidence of its feeding in Puget Sound has been documented as a stopover on its way north or south along the West Coast.

Table D-11. Substances of Concern that Exceeded Applicable Surface Water, Sediment, and Tissue Guidelines in Commencement Bay and Associated Waterway Samples.

Substance	Surface Water (AWQC)[a]	Sediment (SQS)[b]	Tissue Residue (TPCHD)[c]	AWQC (μg/L)	SQS (mg/kg)
Antimony			✓[d]	500[e]	NA
Arsenic	✓	✓	✓	36	57[f]
Beryllium			✓	NA	NA
Cadmium		✓	✓	9.3	5.1[f]
Chromium			✓	50	260[f]
Copper	✓	✓		2.9[g]	390[f]
Lead	✓	✓	✓	8.5	450[f]
Mercury		✓	✓	0.025	0.41[f]
Nickel			✓	8.3	NA
Selenium			✓	71	NA
Silver		✓		0.92[e]	6.1[f]
Zinc		✓	✓	86	410[f]
LPAHs		✓	✓	NA	170[h]
HPAHs		✓		NA	960[h]
PCBs	✓	✓	✓	0.03	12[h]
4,4'-DDD			✓	3.6[e,g]	NA
4,4'-DDE			✓	14[e,g]	NA
1,3-Dichlorobenzene			✓	1,970[i]	NA
1,2-Dichlorobenzene		✓		1,970[i]	2.3[h]
1,4-Dichlorobenzene		✓		NA	3.1[h]
Hexachlorobenzene		✓	✓	NA	0.38[h]
Hexachlorobutadiene		✓	✓	32[g,h]	3.9[h]
Bis(2-ethylhexyl)phthalate		✓	✓	360[g]	47[h]
Di-n-butyl phthalate		✓		NA	220[h]

Table D-11. Substances of Concern that Exceeded Applicable Surface Water, Sediment, and Tissue Guidelines in Commencement Bay and Associated Waterway Samples (continued).

Substance	Surface Water (AWQC)[a]	Sediment (SQS)[b]	Tissue Residue (TPCHD)[c]	AWQC (μg/L)	SQS (mg/kg)
Butylbenzyl phthalate			✓	NA	4.9[h]
Di-methylphthalate			✓	NA	53[h]
Dibenzofuran		✓		NA	15[h]
Tetrachloroethane			✓	NA	NA
Phenol		✓		5,800[e]	0.42[f]
2,4-Dimethylphenol		✓		NA	0.029[f]
2-Methylphenol		✓		NA	0.063[f]
4-Methylphenol		✓		NA	0.67[f]
Pentachlorophenol		✓	✓	7.9	0.36[f]
Benzyl alcohol		✓		NA	0.057[f]
Benzoic acid		✓		NA	0.65[f]

Note: NA - not available

a Identified as a substance of concern based on U.S. EPA chronic ambient water quality criteria for marine organisms; copper, the acute AWQC was used.
b Identified as a substance of concern based on Ecology's Sediment Quality Standards (SQS).
c Identified as a substance of concern based on Tacoma-Pierce County Health Department data.
d ✓ = substances that exceeded guidelines.
e Based on U.S. EPA lowest observed effects level (LOEL).
f SQS based on mg/kg dry weight.
g Acute criteria; chronic criteria not available.
h SQS based on mg/kg organic carbon.
i LOEL for total dichlorobenzenes.

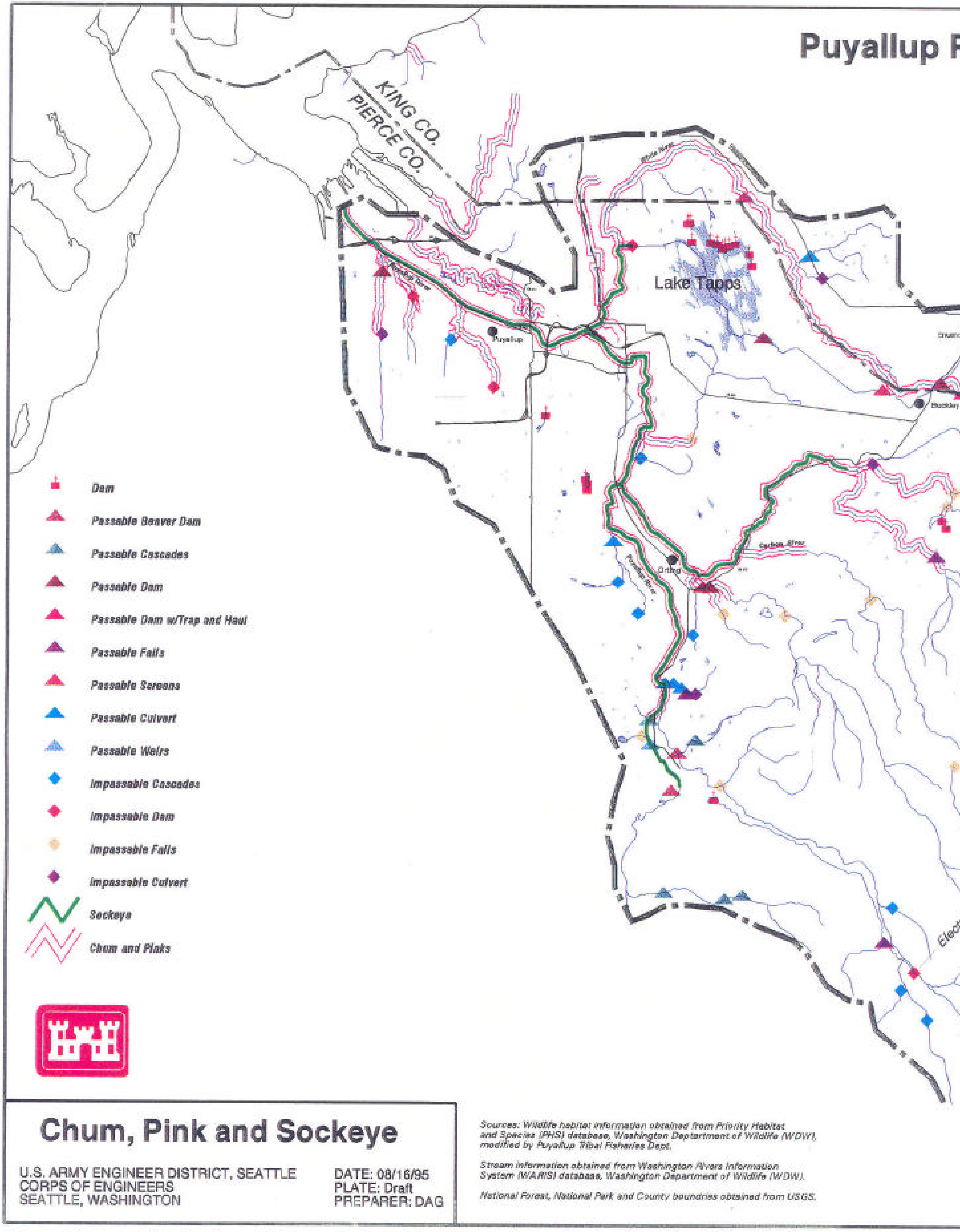
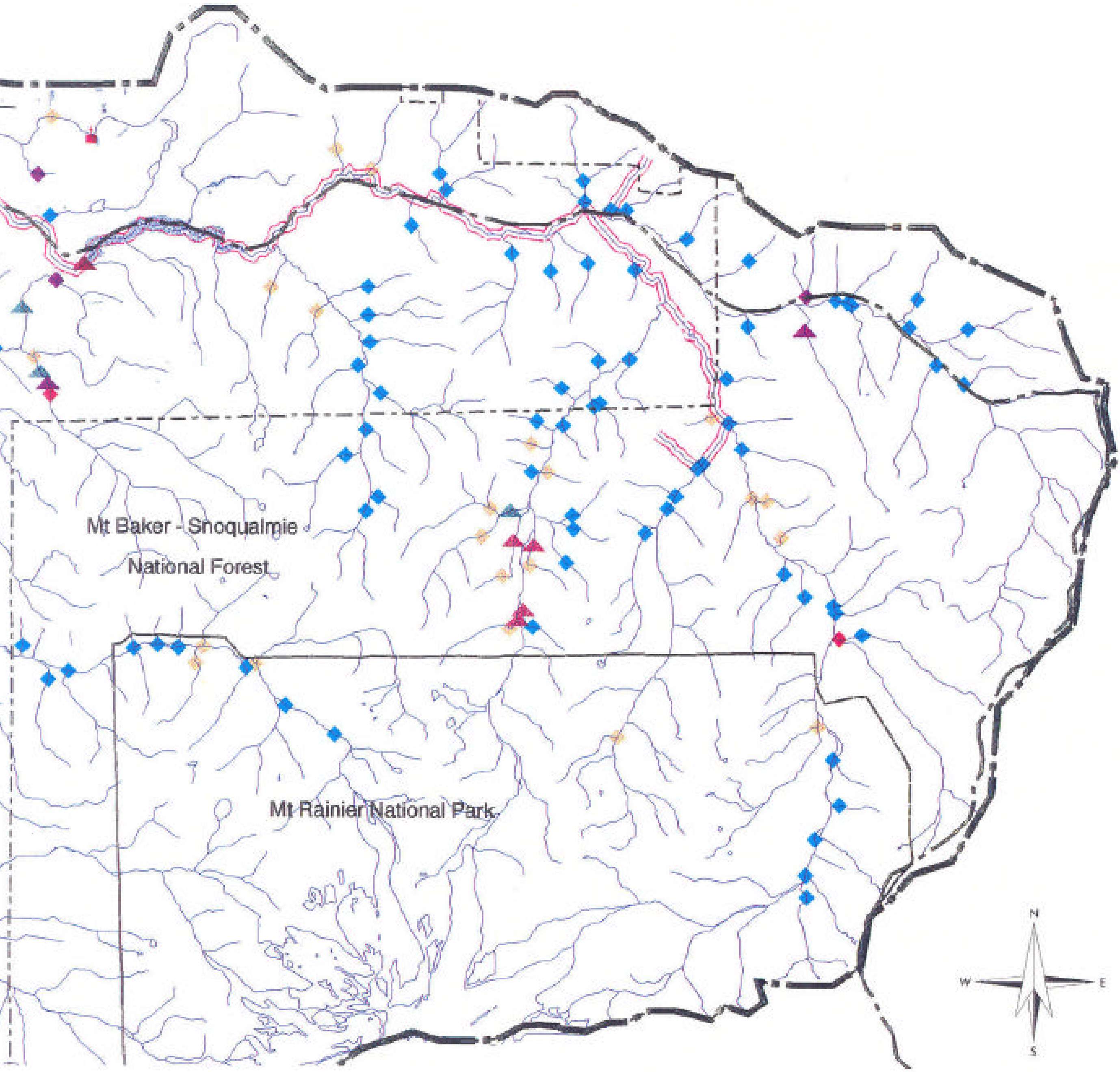


Figure D-1. Distribution of chum, pink, and sockeye salmon in the Puyallup River Basin.

er Basin



Mt Baker - Snoqualmie
National Forest
Mt Rainier National Park
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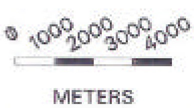

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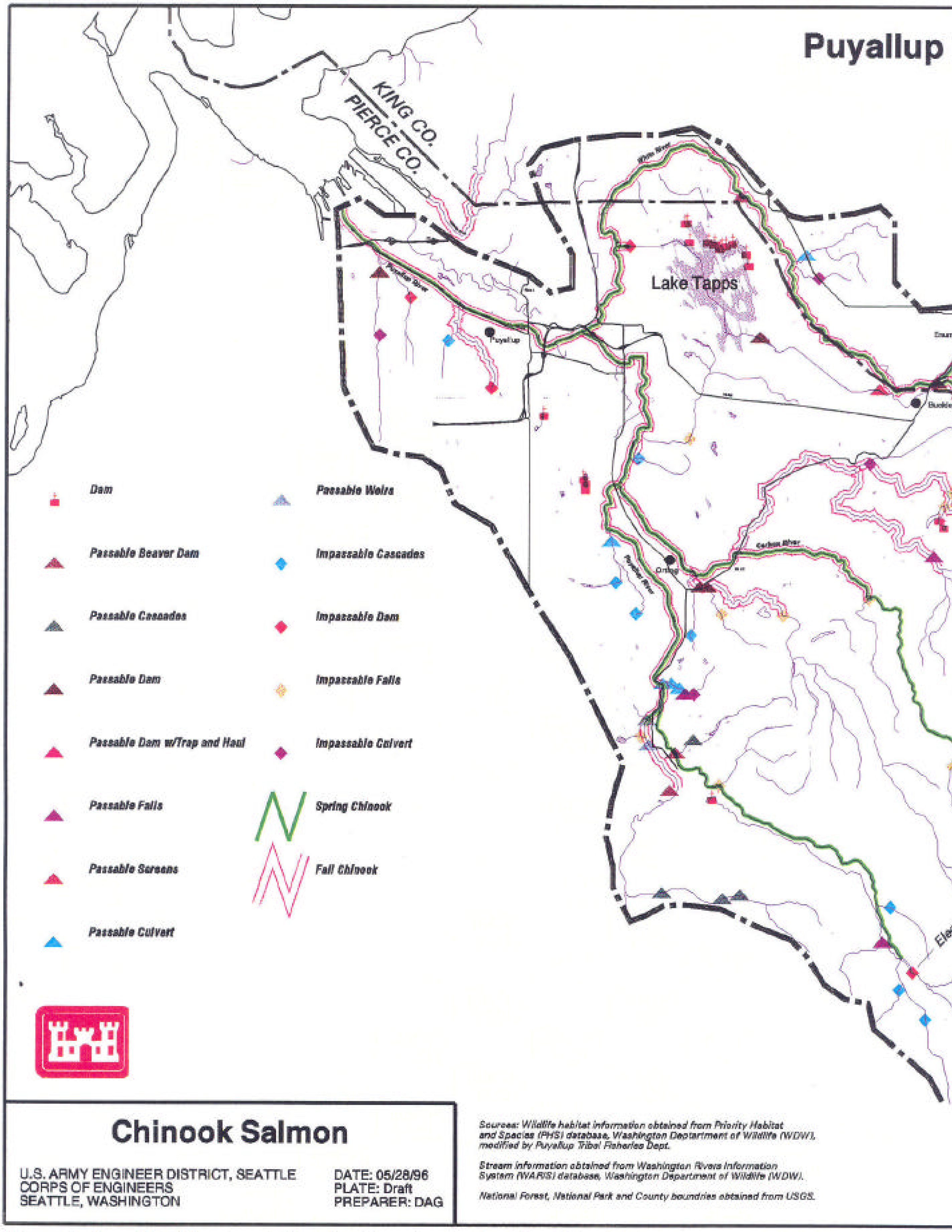
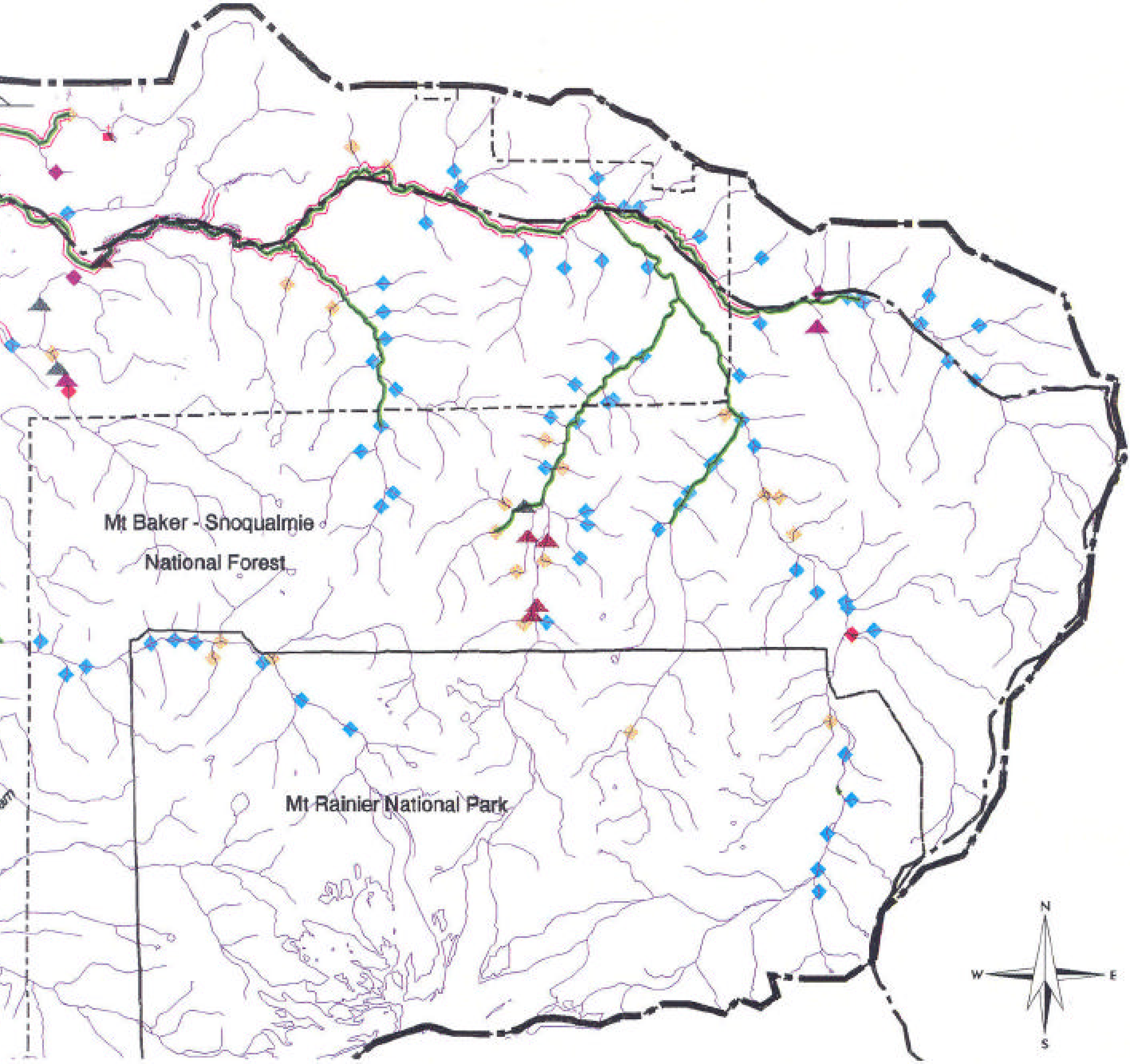


Figure D-2. Distribution of chinook salmon in the Puyallup River Basin.

iver Basin



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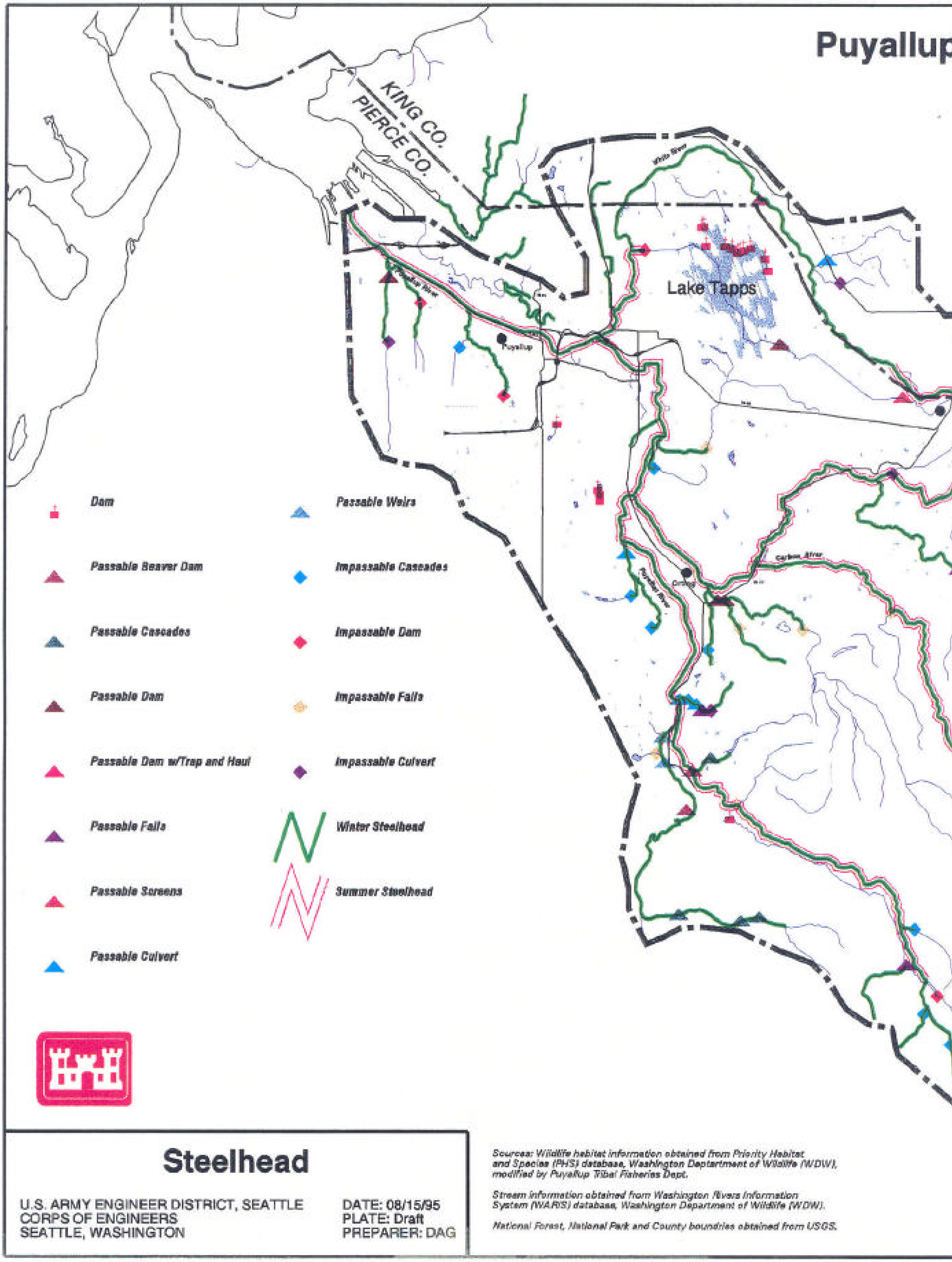
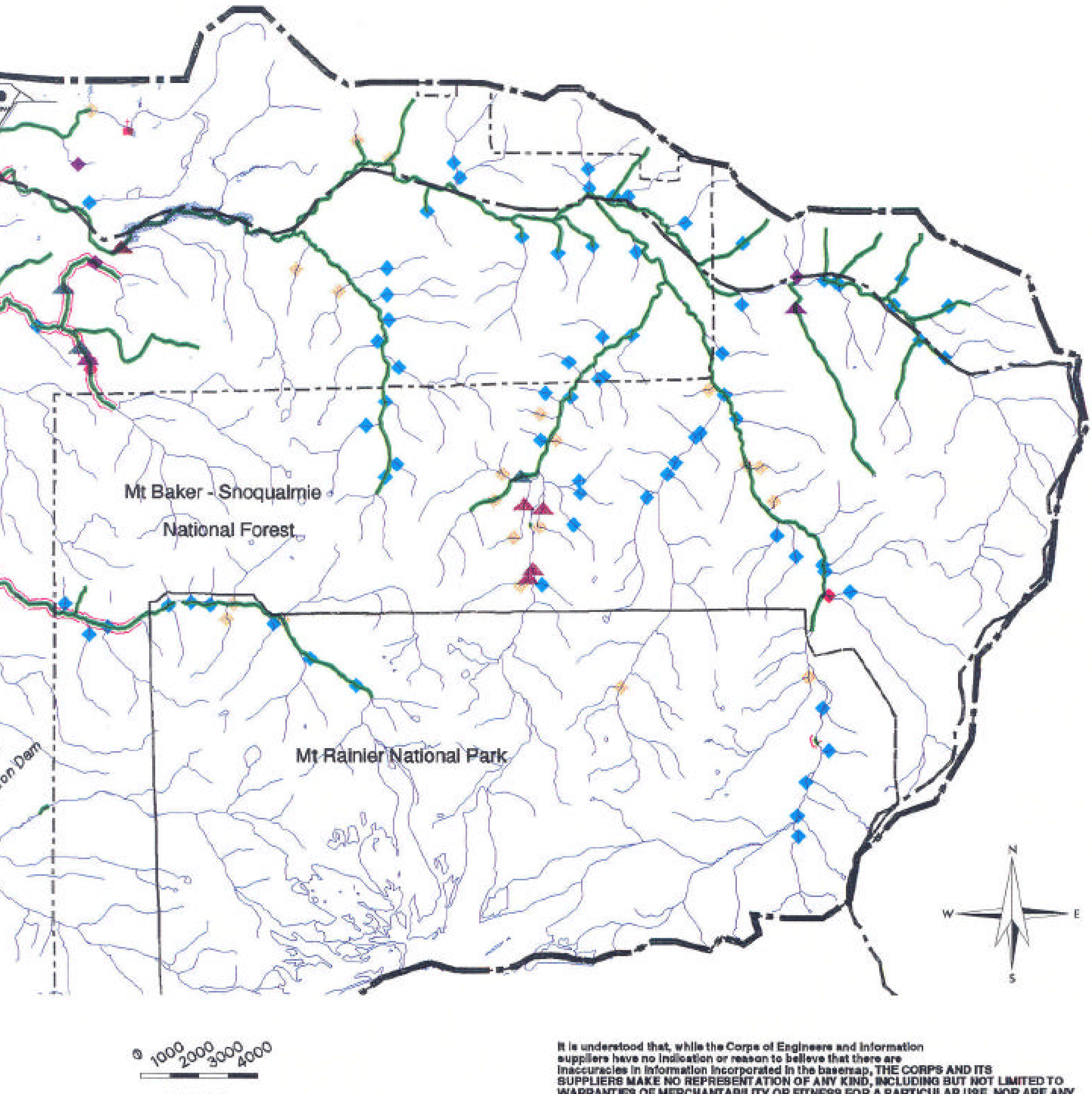


Figure D-3. Distribution of steelhead trout in the Puyallup River Basin.

River Basin



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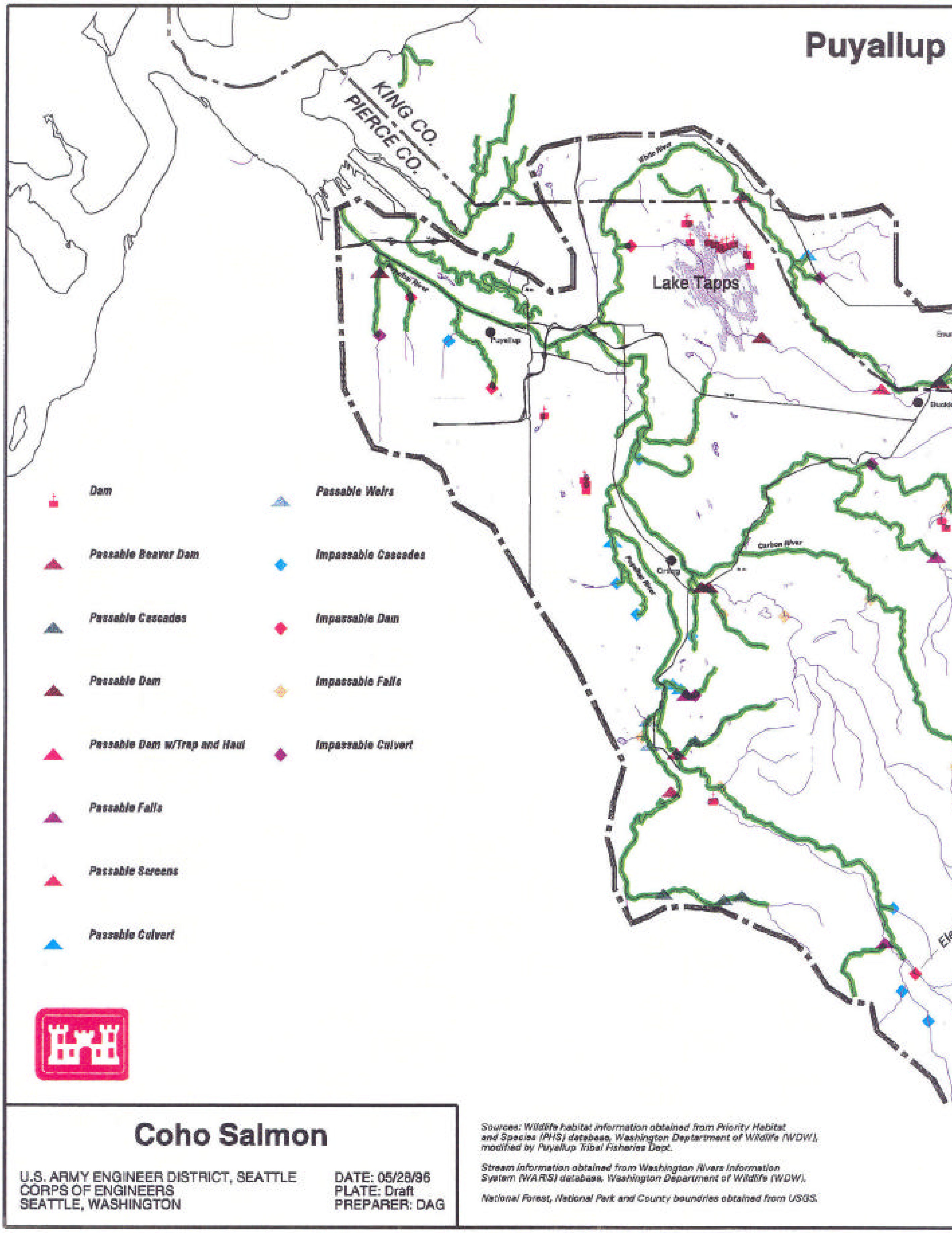
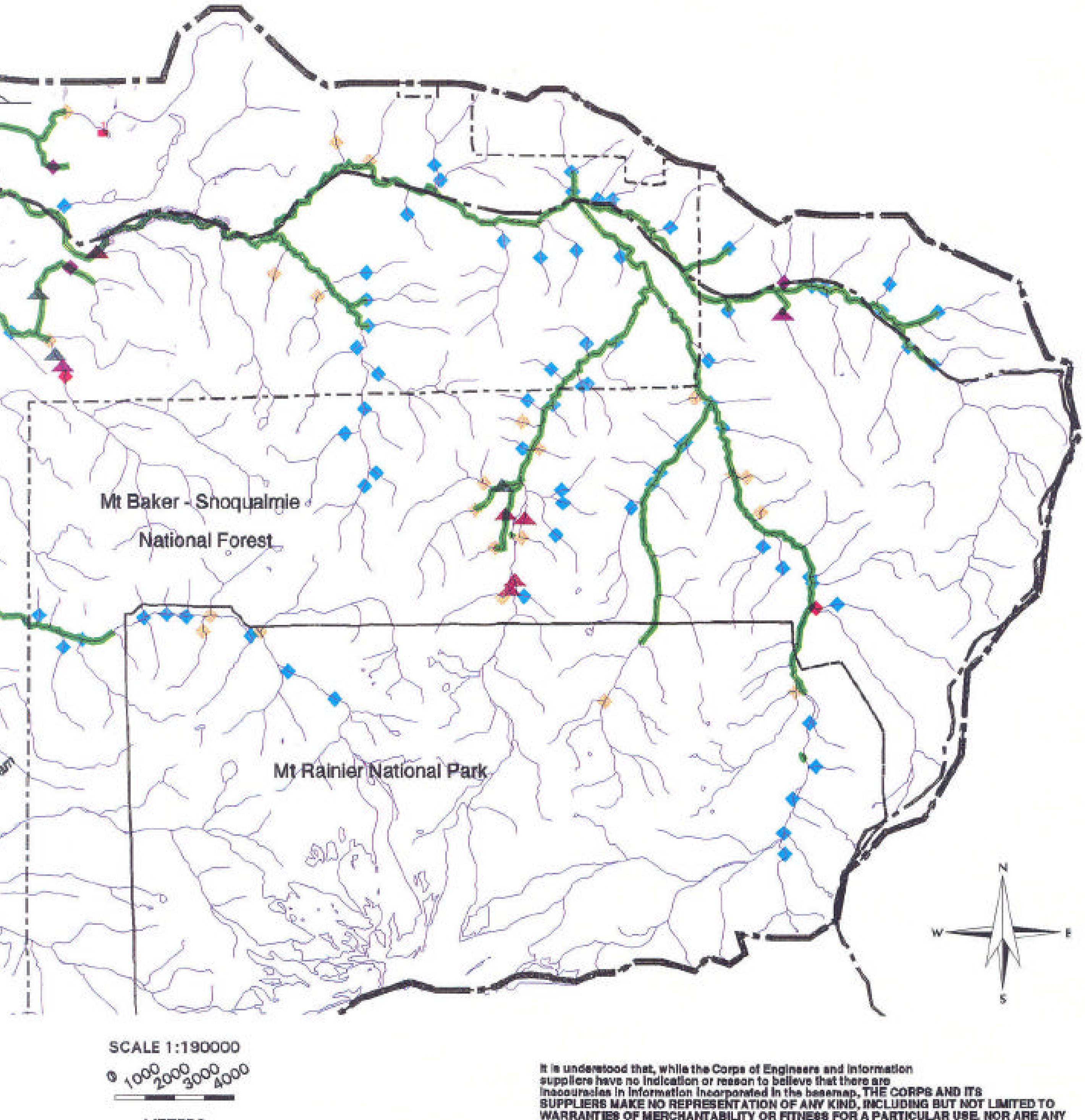


Figure D-4. Distribution of coho salmon in the Puyallup River Basin.

iver Basin



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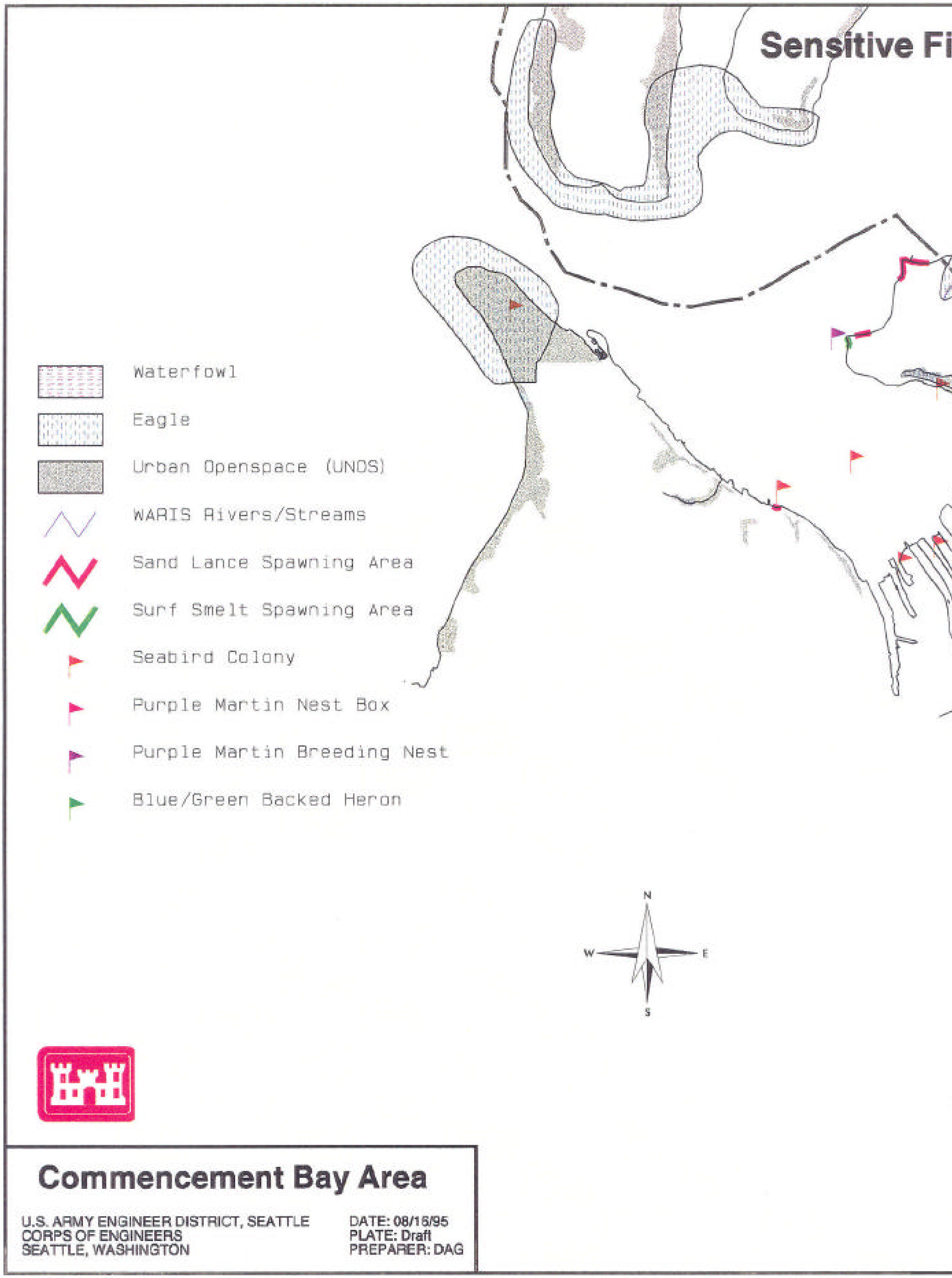
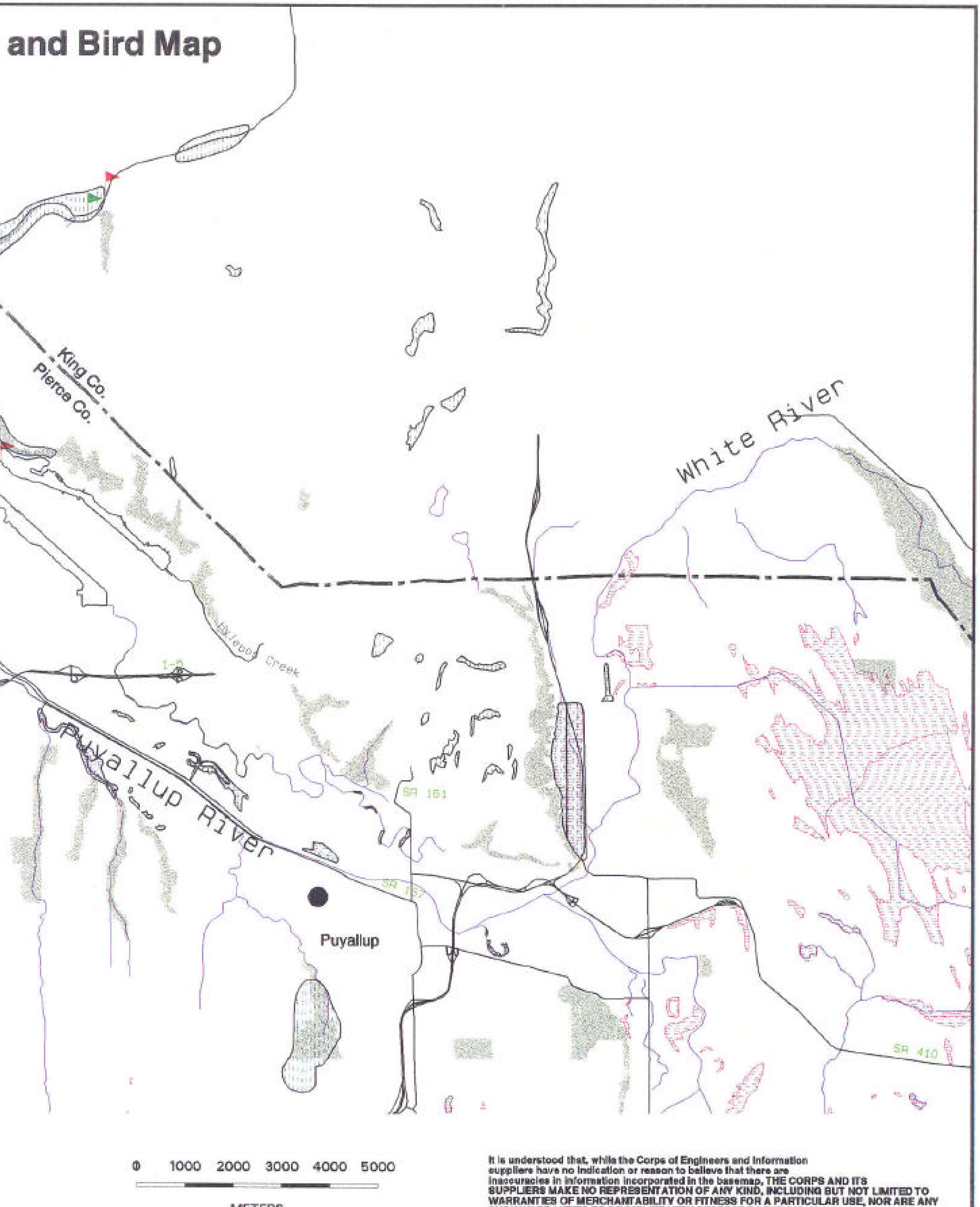


Figure D-5. Distribution of sensitive fish and birds in the Commencement Bay area.

and Bird Map



King Co.
Pierce Co.
White River
Hylebos Creek
I-5
Puyallup River
SR 161
SR 167
Puyallup
SR 410
0 1000 2000 3000 4000 5000
METERS

APPENDIX E

Alternatives Eliminated From Further Evaluation

1.0 INTRODUCTION, GOALS AND CRITERIA FOR EVALUATION

1.1 Introduction

The information provided in this appendix provides greater detail on the preliminary screening of the five alternatives to natural resource and service restoration. The five alternatives were developed by the Trustees during scoping and are defined in section 3.3 of the RP/EIS. The preliminary screening was conducted to evaluate each alternative's ability to meet the identified purpose and need of the CB/NRDA restoration program. Alternatives determined to best meet the stated purpose and need, along with the No Action Alternative (required by CEQ's NEPA regulations, 40 CFR Part 1502.14(d)), are evaluated in detail in the EIS.

1.2 Goals and Objective

The Commencement Bay Restoration Panel developed the following goals and objective which the Trustees believe are comparable to those needs and objectives typically discussed in a NEPA document. Evaluation of the alternatives against the goals and objective listed below results in a systematic determination of which alternatives are best able to meet the purpose and need of the CB/NRDA restoration program. The three goals are to:

1. Meet the statutory objectives of restoring, replacing, rehabilitating and acquiring the equivalent of natural resources and services injured or destroyed as a result of the release of hazardous substances or discharges of oil.

2. Provide alternatives for those natural resources that will not recover without efforts above and beyond regulatory requirements for source control, sediment cleanup, and habitat restoration (e.g., certain fish and wildlife species, and water quality).

3. Provide a diversity of sustainable habitat types and species within the Commencement Bay ecosystem to enhance fish and wildlife resources.

The first objective is to:

> Provide a functioning and sustainable ecosystem where selected habitat and species of injured fish and wildlife will be enhanced to provide a net gain of habitat function beyond existing conditions.

1.3 Criteria for Evaluation

To evaluate the ability of each of the five alternatives to meet these three primary goals and objective, a decision matrix with six evaluation criteria was developed and is presented below. For each restoration alternative, a narrative evaluation of each of the six criteria is provided. Criteria 1 captures the intent of restoration goal 3. Criteria 2 is a measure of goal 2. Because all the alternatives must first and foremost meet the statutory objectives, as outlined in restoration goal 1 above, a specific criteria to discriminate between the alternatives relative to this goal was not developed. Criteria 5 and 6 provide a measure of the first objective. Table 3.4-1, in section 3.4 of the RP/EIS, provides a detailed summary of the evaluation.

Criteria 1: Potential for Ecological Benefits
Potential for direct and indirect ecological benefits to more than one injured natural resource and/or service: Will implementation of this alternative result in a net gain of habitat, injured natural resources, or resource services?

Criteria 2: Provides an Alternative
Provides an alternative for those natural resources that will not recover without efforts above and beyond regulatory requirements for source control, sediment cleanup, and habitat restoration (e.g., certain fish and wildlife species, and water quality).

Criteria 3: Potential for Environmental Impacts
Will additional environmental impacts potentially result from this alternative? For this screening evaluation, impacts related to the central issues of habitat and biological resources, water quality, and sediment quality are considered.

Criteria 4: Cost Effectiveness
Does this restoration alternative achieve the desired benefits in a cost effective manner considering direct and indirect environmental, social and economic costs?

Criteria 5: Probability of Success
Will implementation of this alternative result in restored habitats that are self-maintaining over the long-term? Does the data and/or literature support this restoration alternative? Are technology and management skills available to successfully implement this restoration alternative?

Criteria 6: Reduces Fragmentation of Landscape
Will this alternative reduce the present degree of fragmentation of the landscape by increasing habitat connectivity, buffers, and access for injured species?

2.0 PRELIMINARY SCREENING OF ALTERNATIVES

2.1 No Action Alternative

The No Action Alternative must be considered to comply with NEPA regulations and will be evaluated based on expected conditions under current programs and regulations pursued by tribes and agencies outside the NRDA process.

Criteria 1: Potential for Ecological Benefits
Under this alternative, the potential for direct and indirect ecological benefits to potentially injured species is unpredictable. Natural processes determine the trajectory of the ecosystem rather than human efforts to enhance natural resources and services. Future EPA and Ecology remedial actions and source control will also influence the potential for ecological benefits.

Criteria 2: Provides an Alternative
The No Action Alternative does not provide for resources that will not recover without efforts beyond current non-NRDA regulatory requirements. No NRDA funds would be directed at improving species, habitat conditions, or resource services. However, on-going regulatory actions (e.g., source control and sediment remediation) and currently existing agency and tribal restoration programs, which are not part of the CB/NRDA process, would proceed.

Criteria 3: Potential for Environmental Impacts

Water Quality. Source control activities that are independent of the CB/NRDA process could result in water quality improvements, but under this alternative no additional NRDA actions that may improve degraded water quality in either the primary or expanded study areas would occur. It is conceivable that further degradation of water quality could occur despite source control activities in the Bay. Further degradation of water quality due to the No Action Alternative could be an adverse effect.

Sediment Quality. Sediment quality improvements could result from sediment remediation activities that are independent of the CB/NRDA process, but under this alternative no NRDA actions would be taken that may improve degraded sediment quality in either the Bay or the Basin. Although sedimentation will occur naturally in most aquatic systems, this process may be too slow to bury contaminants deep enough to fully remove them from contact with aquatic resources. In addition, mixing of sediments through burrowing and sediment reworking by sediment-dwelling animals will continuously incorporate contaminated sediments into newly deposited sediments (CB/NRT, 1995).

Habitat. Habitat improvement activities that would take place under this alternative would be limited to non-NRDA programs administered by tribes, agencies, or local governments. Under the No Action Alternative, there would be limited capacity for improvement of the overall habitat quality in the study area. Vacant habitats, which might otherwise be enhanced or restored for injured species or services under one of the other alternatives, could become available for development. Conversion of these potential restoration sites to industrial, commercial, or residential uses would further fragment the existing landscape and potentially contribute new anthropogenic stresses and disturbances to the system.

Fish and Wildlife. No direct short-term or long-term impacts to fish and wildlife should occur under this alternative. However, because this alternative does nothing to address the factors that may have resulted in injuries to natural resources, the potential is high for continued indirect long-term impacts to natural resources and services. Fisheries resources would continue to be stressed by elevated water temperatures, flow diversions, lack of vegetative cover, dams, road construction and other development in or adjacent to fish habitat, irrigation for farming, and draining of wetlands (Ecology, 1995a; South Puget Sound Spring Chinook Technical Committee, 1995a). These stresses could potentially increase the susceptibility of fishery resources to contaminants. New development could result in further loss of critical habitats that support injured species, including salmonids, invertebrates, macroinvertebrates, and birds.

The No Action Alternative could indirectly result in loss of the few viable estuarine and riverine habitats that remain in the primary study area, if no action leads to continued degradation of these habitats rather than natural recovery. Juvenile anadromous fish, including chum, pink, and chinook salmon depend upon the shallow habitats in the study area for feeding and rearing during their outmigration (Shreffler et al., 1992; Corps et al., 1993). The temporal and spatial distribution of these species within the Bay and Basin must be considered, because if the No Action Alternative fails to result in improved conditions, these species could be adversely affected over the long-term. The continued degradation of the riverine and estuarine habitats used by these species will further affect these species through reduction in quiet areas for rearing, reduction and contamination of prey resources, and stress due to increased water temperature or increased suspended sediments.

The potentially injured non-anadromous species in the study area could also be further impacted under this alternative. Many of these species spend their entire life cycle within the study area, and thus depend upon the system for food and reproduction (Eaton and Dinnel, 1993). If the No Action Alternative fails to result in improved habitat conditions, further loss of habitat and continued contamination of water and sediments would adversely affect this group of species over the long-term.

Many resident and migratory birds that occur in the Commencement Bay study area utilize aquatic habitats for feeding (Appendix A). The majority of these species rely directly on mudflats, marshes, and eelgrass meadows in the region. These habitats could be further degraded if the No Action Alternative failed to result in improvements to existing conditions. In addition, predatory birds such as the peregrine falcon, osprey, and bald eagle would be affected by reduction in food resources.

Threatened and Endangered Species. No direct short-term or long-term impacts to threatened and endangered species should occur under this alternative. However, the No

Action Alternative could indirectly result in continued loss of habitat and degradation of water quality, which would further stress these species over the long-term. Loss of food resources and nesting and feeding habitat for all avifauna and loss of feeding and rearing areas for chinook salmon would also reduce these populations. Reduced water flow would adversely affect the survival of juvenile and adult White River spring chinook salmon. Degradation of spawning areas upstream of the Bay would also affect the viability of the population.

Criteria 4: Cost Effectiveness
One aspect of significance to the analysis of the alternatives in this Programmatic EIS is the assumption that under the No Action Alternative, lands in the study area are subject to private use and could be used for some purposes that could effect the habitat and possibly the resources that have been injured. Because this is the case, it is assumed for purposes of analysis in this EIS that those lands would be put to such uses and would result in adverse effects to the injured natural resources and services being analyzed.

Based upon the above mentioned assumption, this alternative would not provide a diversity of sustainable habitat types and species within the Bay and Basin. Although there are no economic expenditures associated with the No Action Alternative, there are definite environmental and social costs that outweigh the lack of economic expenditures. The environmental costs are: potential development of currently vacant properties which might otherwise be restored under another alternative; potential loss of remaining critical habitats that currently support injured species; further injury to natural resources and services; and further fragmentation of the landscape. The primary social cost is the continued loss of natural resources and services to the ecosystem if the Bay or Basin fails to recover naturally.

Criteria 5: Probability of Success
The probability of successful recovery of either the Bay or Basin is low, because no actions are specifically taken to improve existing conditions.

Criteria 6: Reduces Fragmentation of Landscape
This alternative would not reduce fragmentation of the landscape and could even increase it, when habitats which might otherwise be restored under one of the alternatives, may be developed instead for industrial or residential uses.

2.2 Species-Specific Alternative

This alternative would focus on the restoration of key species or group of species injured from the release of hazardous substances and discharges of oil as identified in the CB/NRDA process, rather than on the restoration of generic habitat units or patches. Restoration efforts could vary from artificial enhancement and stocking to creation of species-specific habitat.

Criteria 1: Potential for Ecological Benefits

Species-specific restoration has a moderate potential for direct and indirect ecological benefits to more than one natural resource or service. Salmonids, demersal fish, shellfish, and waterfowl are among the species groups that could benefit from this alternative. This alternative targets specific populations of individual species or groups of species that were injured by the release of hazardous substances or discharges of oil, as opposed to restoration of habitats for multiple species. The principal drawback of species-specific restoration is that it is less likely to provide a diversity of sustainable habitat types and species (goal 3) than some of the other alternatives (e.g., habitat function, integrated approach), because only certain structural or functional attributes at a particular site are re-established or improved rather than a range of ecosystem structural and functional attributes.

Criteria 2: Provides an Alternative

This alternative has moderate potential to foster the recovery of injured species that will not recover without efforts beyond regulatory requirements for source control, sediment cleanup, and habitat restoration. Restoration actions would focus on increasing the numbers and/or distribution of specific species or species groups. The challenge of species-specific restoration is first identifying what is limiting the numbers and/or distribution of the target species, and then reducing this limiting factor.

Criteria 3: Potential for Environmental Impacts

Water and Sediment Quality. Depending upon the particular restoration project, if implemented, this alternative could have negative short- or long-term impacts on water and sediment quality. Potential impacts include:

- Net pens, hatcheries, artificial incubators, aquaculture facilities: could significantly degrade water and sediment quality over the long-term by artificially raising concentrations of organic material, inorganic nutrients and bacteria and using certain chemicals to control diseases, and by degradation of sediment quality over the long-term through organic enrichment of bottom substrates (Ecology, 1995a). Proper siting of delayed-release net pens should not have long-term adverse effects upon water or sediment quality (Port of Seattle, 1992).

- Creating or enhancing salmonid feeding, rearing, or spawning habitat: could have adverse short-term water quality impacts associated with construction activities, such as increased turbidity and total suspended solids.

- Artificial reefs, seeding mudflats with clams or oysters, distributing shell hash: Could have adverse short-term water and sediment quality impacts from construction activities.

- Creating or enhancing nesting, loafing, feeding, and rearing habitats for waterfowl: Could have adverse short-term water quality impacts associated with construction activities, such as increased turbidity and total suspended solids.

- Although it is the intention of the Trustees to work only in areas that have clean sediments, one possible adverse effect that must be mentioned is the possibility of resuspending contaminants during in-water construction. Every precaution would be made to foresee and avoid such an event. Conscientious monitoring at the restoration sites should prevent resuspension of any contaminant. Still, creating or enhancing habitats could have short-term adverse water quality impacts associated with construction activities, such as increased turbidity and total suspended solids, mentioned previously.

Habitat. Additional adverse effects from the Species-Specific Alternative, in addition to the water or sediment quality impacts discussed above, could include:

- Construction and operation of net pens, hatcheries, artificial incubators and aquaculture facilities: Short-term noise and air impacts; short- or long-term disruptions of animal migrations, breeding, nesting; short-term disturbance of existing plant communities; temporary disturbance of ecological processes such as detrital export or primary production; increased probability of long-term disease impacts; increased probability of long-term competition, predation and genetic interactions with native species;

- Creating or enhancing salmonid feeding, rearing, or spawning habitat: Short-term noise and air impacts from construction activities; short-term disruptions of existing plant and animal communities; temporary disturbance of ecological processes;

- Artificial reefs, seeding mudflats with clams or oysters, distributing shell hash: Short-term noise and air impacts; short- or long-term disruptions of animal migrations, breeding, nesting; short- and long-term disturbance of existing plant communities; temporary disturbance of ecological process such as detrital export or primary production; increased organic matter and nutrient flux;

- Creating or enhancing nesting, rearing, or loafing habitat for waterfowl: Short-term noise and air impacts from construction activities; short- or long-term disruptions of animal migrations, breeding, nesting; short-term disturbance of existing plant communities; temporary disturbance of ecological processes such as detrital export or primary production.

Under this alternative, only the habitat requirements of a single species or groups of species would be considered in developing the restoration plans for a particular site. Therefore, although the habitat restoration would benefit the targeted species, it may not improve conditions for other species. For example, clam enhancement projects are well developed in Puget Sound. These projects often involve placement of gravel on constructed intertidal beaches, followed by seeding of the gravel with high densities of bivalves. Although clam densities are enhanced well above those in the former habitat, higher levels of organic matter and nutrient flux are known to occur in these areas (Thom et al., 1994). Any clam enhancement projects would have to be sited away from contaminated sites so as not to create a public health hazard. There is a health advisory for consumption of clams from Commencement Bay.

Fish and Wildlife. This alternative has a moderate potential for short-term effects on fish and wildlife, although some species or groups could directly benefit from the species-specific alternative. In some settings, this alternative could involve restoration of one or several species, at the expense of other components of the ecosystem. In addition to the potential trade-off of one species over another, this alternative could result in increased competition, predation, and genetic interactions between the target species and other non-injured species. For example, increasing the production of hatchery salmon has the potential to result in competition or predation with other resident and anadromous fishes, and genetic interactions with other salmonids.

Threatened and Endangered Species. This alternative should result in no short- or long-term injury to threatened or endangered species. The likelihood of a significant negative effect on an injured species because of enhancement of a threatened or endangered species can be avoided or minimized through consideration of the specific impacts from each potential restoration project.

Criteria 4: Cost Effectiveness

The benefit of this alternative to specific injured species is high relative to the cost. In comparison to the other alternatives, the costs of species-specific restoration tend to be well defined and limited by the specific scope of the actions that will benefit target species. The focus of this alternative is on one attribute, rather than the ecosystem, and may result in restored habitats which are not ecologically or economically sustainable over time. Of the five alternatives, this one is perhaps the best suited to restoration of individual injured species that can benefit directly from enhancement of structural or functional attributes of the estuarine or riverine system. Cost estimates for specific types of species-specific restoration actions are listed below:

- Salmon hatchery: the White River Hatchery, constructed in the late 1980's, cost an estimated $7 million; operation and maintenance costs are $250,000 annually (Malcom, 1995, personal communication); operation and maintenance costs for the Puyallup Tribal Hatchery are $274,000 annually (Ladley, 1995, personal communication).

- Artificial rocky reef: the quarried rock used in a rocky reef in Elliott Bay, which was constructed as mitigation for filling of Piers 90 and 91, costs approximately $50,000 ($10,000 per load) in 1987 dollars; total project cost including siting and design, pre-and-post-project monitoring, and reporting was estimated to be $100,000 (Buckley, 1995, personal communication).

- Off-channel salmon rearing and over-wintering ponds: construction of salmonid rearing ponds in the White River was approximately $250,000 (Malcom, 1995, personal communication).

- Creation of 500 square feet of spawning habitat, and restoring anadromous access to over two miles of spawning and rearing habitat was under $1,000 (Malcom, 1996, personal communication).

Criteria 5: Probability of Success

If restoration is targeted at habitats that are critical to the survival of a specific injured population or factors that limit the survival of that population (i.e., "limiting factors"), the probability of success would be moderate. Typically, species-specific restoration attempts to manipulate only the structural or functional attributes of the system that are most important in sustaining the critical life history requirements of key fish and wildlife species. Because of the focus on only certain attributes rather than the whole ecosystem, this alternative may not result in restored habitats that are economically and environmentally sustainable over the long-term. Species-specific restoration projects often require extensive, ongoing maintenance.

In previous cases where species-specific restoration was carefully implemented, success has been good. An example includes restoration efforts for the recovery of bald eagles. In addition, project performance (i.e., success or failure) under this alternative is relatively easy to evaluate as long as measurable functional performance criteria are established at the onset of a project.

Criteria 6: Reduces Fragmentation of Landscape

From a landscape ecology perspective, species-specific restoration tends to be piecemeal, and thus is not typically a good alternative for reducing habitat fragmentation and restoring degraded habitats so that they are integrated into the larger landscape (Shreffler and Thom, 1993). Species-specific actions attempt to fill certain ecological niches, but are very limited in their ability to alter the structure or function of the landscape.

2.3 Habitat Function Alternative

This alternative would involve actions designed primarily to benefit certain key habitat types that support a range of species. It assumes that if habitat is created, the species will follow, resulting in habitat for a greater diversity of species.

Criteria 1: Probability of Ecological Benefits

Habitat function restoration focuses on providing direct and indirect ecological benefits to multiple injured species. This alternative would also provide benefits to non-injured species and natural resource related services. Typical actions include enhancement and creation of new habitat, or restoration of functions of existing habitats. In addition, habitat restoration typically provides benefits outside of the project area, such as detrital export, improved sediment and water quality, and nutrient flux.

Criteria 2: Provides an Alternative
This alternative would promote greater habitat and species diversity, and is an excellent alternative for multiple natural resources and services which will not recover without efforts beyond regulatory requirements.

Criteria 3: Potential for Environmental Impacts

Water Quality. This alternative, if implemented, would probably have only short-term water quality impacts in the study area. Short-term adverse effects could result from increased sedimentation or turbidity resulting from construction activities, such as excavation, dredging, breaching of dikes, stream bank revegetation, or placement of instream structures (e.g., large woody debris, root wads, log weirs). As with other alternatives which include in-water work, resuspending contaminants during construction is a possibility. Whenever this activity is undertaken every precaution would be made to foresee and avoid such an event. Conscientious monitoring at the restoration sites should prevent resuspension of any contaminant.

Sediment Quality. Under the Habitat Function Alternative, only short-term adverse effects to sediment quality would be anticipated. Construction activities associated with the typical actions listed above could result in increased sedimentation and turbidity.

Habitat functions are generally inhibited or otherwise altered by contaminants in sediments (e.g., Kaputska and Reporter, 1991). In addition, contaminants in sediments can be transferred to the food web through uptake by plants growing in contaminated sediments. Construction of new habitats, or restoration or enhancement of existing habitats, should result in clean substrata for development of high quality habitat functions.

Habitat. Additional adverse effects that could result from this alternative are derived principally from construction activities required to restore target habitats. These effects could include short-term noise and air pollution, short-term reductions in sediment and/or water quality, temporary and long-term disturbance of existing plant communities, and short and long-term disruptions of animal migrations, breeding and nesting.

One of the drawbacks to habitat restoration is that there may be significant lag time (e.g., more than five years) before the diverse ecological functions are replaced. Also, existing viable habitat may be altered (e.g., creation of a wetland from viable upland habitat, dike breaching). Recognizing the significant time lag between habitat restoration and the replacement of ecological functions, consideration could be given, during the interim, to other alternatives, such as acquisition of equivalent resources, to reduce the time period of departure from baseline conditions.

Fish and Wildlife. This alternative directly addresses habitat-related factors limiting the use of the study area by injured fish and wildlife. New habitat restoration, enhancement, or creation could result in some losses of habitats, but these losses should be minimal in view of the goal of this alternative to restore degraded habitats that directly or indirectly support injured species such as salmonids, demersal fish, epibenthic invertebrates and macro-invertebrates and birds.

Implementation of this alternative would improve conditions for injured fish and wildlife. Previous habitat restoration projects demonstrate it is possible to improve the functioning of benthic habitats, initiate recovery of natural habitats such as eelgrass and salt marshes, improve the health of fish and shellfish, and improve habitat support for nesting, feeding, and rearing of shorebirds and waterfowl (Simenstad and Thom, 1992). In addition, juvenile anadromous fish such as chum, pink, coho, and chinook salmon, and steelhead trout, would benefit from this alternative through increases in quiet areas for rearing and feeding, greater numbers of prey resources, and less stress from elevated water temperatures and suspended sediment loads.

The injured non-anadromous species that inhabit the study area should benefit under this alternative. It is expected that this alternative would reduce the exposure to contaminants, the incidence of histopathological disorders, and would decrease the body burdens of contaminants, due to the placement or exposure of clean sediments as the substrata for the development of high quality habitat functions.

Restoration of habitats would improve conditions for the resident and migratory birds that occur in Commencement Bay (Appendix A). Predatory birds such as the peregrine falcon, osprey, and the bald eagle would benefit also in terms of improved prey availability.

Threatened and Endangered Species. No adverse effect to threatened and endangered species would be expected to result from this alternative. Improved habitat functions would benefit these species. Increased prey resources and nesting and feeding habitat for all avifauna and increased feeding and rearing areas for chinook salmon should result in increases in these populations. Improved water flow would benefit not only the survival of adult White River spring chinook salmon, but also the survival of juvenile salmon. Improvement of spawning areas in the expanded study area would also have benefit to the viability of this population.

<u>Criteria 4: Cost Effectiveness</u>

Both the benefits and the costs of habitat restoration are typically high. One of the principal economic constraints on this type of restoration is conflicting land uses. In an urban setting such as Commencement Bay, available sites for habitat restoration are often difficult to find and expensive to acquire (Simenstad and Thom, 1992). More cost-effective opportunities for habitat function restoration may be available in the Basin.

Habitat restoration or creation is an expensive undertaking. The costs listed below include siting, design, and construction, but do not include monitoring unless specified.

- Estuarine restoration: based upon a recent estuarine restoration project in the Duwamish River estuary (GSA site $250,000 for 1 acre; Turning Basin site $200,000 for 1 acre) and in Commencement Bay (Middle Waterway site $430,000 for approximately 3.3 acres), an estimated cost range for habitat restoration in urban areas in the Pacific Northwest is $230,000/acre (Clark, 1995, personal communication).

- Eelgrass transplanting: eelgrass (*Zostra marina*) has been successfully transplanted on the Atlantic, Gulf and Pacific coasts; transplanting on the Pacific coast is typically more difficult than the Gulf or Atlantic coasts. The estimated cost/unit area varies considerably according to site, but an average cost for transplanting eelgrass is $14,974/acre ($37,000/ha) according to a recent interview paper by Fonseca et al. (1995).

- Guinon (1989) documented field implementation costs for 25 wetland restoration projects throughout California and reported a range from $1,626 to $240,000 per acre (1989 dollars). Sources for wetland restoration suggest that the empirical estimates of wetland restoration costs in the literature are generally of poor quality. Costs appear to depend upon what is being restored, how badly it is damaged, and how fast, how complete and how permanent the repairs need to be (Shreffler et al., 1995).

- Design and construction of a cross levee culvert, three bridges, installation of culverts and breach work for the Spencer Island wetland restoration and wildlife enhancement project cost $762,030 (1994 dollars) to restore intertidal inundation to 50 acres (Tanner, 1994, personal communication).

- Tidal marsh construction: The cost for a technique for controlling upland bank erosion through tidal marsh construction was $50 to $55 (1994 dollars) per linear foot of shoreline treated (Garbisch and Garbisch, 1994).

Criteria 5: Probability of Success

Habitat function restoration is a holistic process that cannot be achieved through the isolated manipulation of individual structural or functional attributes. Achievement of this form of restoration entails returning the site's structure and function, both locally and within the broader watershed context, to a close approximation of the baseline condition. The overall constraint is the lack of quantitative data to successfully mimic the habitat structure and to replicate the complex suite of processes and functions of the historic condition, or natural reference habitat. Despite this constraint, habitat restoration has been quite successful in the past; selected examples from Washington, Oregon, and California include the restored Gog-le-hi-te wetland complex in the Puyallup River estuary (Simenstad and Thom, 1992), the Spencer island dike breach in the Snohomish River estuary (Tanner, 1993), the Salmon River Dike Breach in the Salmon River estuary (Morlan and Frenkle, 1992), and the Salmonberry Slough in the Chehalis River estuary (Simenstad et al., 1992), as well as numerous successful stream restoration projects (e.g., Kondolf and Micheli, 1995).

Criteria 6: Reduces Fragmentation of Landscape
Habitat function restoration is an excellent method for reducing fragmentation of the landscape. This alternative is well suited for acquiring and enhancing already functioning habitats or creating, restoring, or enhancing degraded habitats to emulate a natural self-maintaining habitat that is structurally and functionally integrated within the landscape in which it occurs. The chances of successful habitat function restoration increase if the restored habitat is linked to existing, viable natural habitats, thereby reducing fragmentation of the landscape.

2.4 Acquisition of Equivalent Natural Resources and Services Alternative

Under this alternative, projects and activities would focus on the acquisition of equivalent natural resources and services which would be the same as or substantially similar to the natural resource or service which was injured but which could not otherwise be restored.

Criteria 1: Potential for Ecological Benefits
The Acquisition of Equivalent Natural Resources and Services Alternative does not attempt to directly restore injured natural resources or services, but does have moderate potential for indirect ecological benefits to substantially similar resources or services. This alternative attempts to either substitute another resource for the injured resources or services that provides the same or similar services, or improve the acquired resources to make up for the lost resources or services.

Criteria 2: Provides an Alternative
Acquisition of equivalent resources is one of the best alternatives for those resources that will not recover without efforts beyond regulatory requirements for source control, sediment clean-up, and habitat restoration. This alternative also provides a mechanism for reducing the period of time in which natural resources and services are not performing at the baseline level because of the lag time following habitat restoration. This alternative should be considered primarily in those cases where restoration of the injured resource or service is technically infeasible or the cost is too prohibitive in the judgement of the Trustees.

Criteria 3: Potential for Environmental Impacts

Water and Sediment Quality. Some actions that could be implemented under this alternative would have negative short- or long-term impacts on sediment or water quality if implemented:

- Managing agricultural land for waterfowl food production: no anticipated adverse effects to water or sediment quality.

- Creating habitats to provide equivalent services: short-term increases in sedimentation or turbidity resulting from construction activities. As with other alternatives which include in-water work, resuspending contaminants during construction is a possibility. Whenever this activity is undertaken every precaution would be made to foresee and avoid such an event.

- Hatcheries, permanent net pens, aquaculture facilities: could significantly degrade water quality over the long-term by artificially raising concentrations of inorganic nutrients and bacteria and using certain chemicals to control diseases, and could result in an increased probability of long-term organic enrichment of bottom substrates.

- Artificial reefs, seeding hard-shell clams or oysters: could result in short-term increases in turbidity and total suspended solids.

The potential for additional impacts from this alternative is difficult to predict, due to the range of actions that could occur. The following is a partial list of adverse effects that could occur under this alternative: short-term noise and air pollution resulting from construction activities; temporary or long-term disruption of animal migrations, breeding, nesting; short- or long-term disturbance of existing plant communities; increased probability of long-term disease impacts associated with net pens, hatcheries, and aquaculture facilities; increased probability of long-term competition, predation, and genetic interactions from hatcheries, artificial reefs, net pens, and aquaculture facilities.

Prior to implementation of any shellfish aquaculture projects, human and environmental risk would be evaluated. There is a human health advisory in the Bay for ingestion of shellfish and there would probably be a significant time lag before shellfish were certified for human consumption. Although wildlife species could benefit from shellfish enhancement, shellfish have significant bioaccumulation potential (e.g., Becker et al., 1990).

Fish and Wildlife. This alternative has moderate potential for adverse effects. For example, resources that are either acquired or replaced could have adverse effects (i.e., predation, competition, genetic interactions) upon existing natural resources of concern, because of the similarity between the acquired natural resources and/or services and the injured resources or services. An example of such adverse effects could be the replacement of native salmon stocks with hatchery salmon stocks of the same species, which could potentially compete, prey upon, or have deleterious genetic interactions with the native stocks.

Limiting factors would not be eliminated for juvenile anadromous fish, such as chum, pink, and chinook salmon which depend upon the shallow water habitats in the study area for feeding and rearing during their outmigration (Shreffler et al., 1992; Corps et al., 1993). Actions which result in larger outmigrating juvenile salmonids or alternations in timing release of juveniles may reduce competition between naturally spawned fish and hatchery fish in the estuary.

Under this alternative, there may be further adverse effects to the non-anadromous fish species that inhabit the study area. Many of these species spend their entire life cycle within

Criteria 1: Probability of Ecological Benefits
The Integrated Approach is the most likely of the five alternatives to restore injured natural resources and services to the baseline condition. This alternative maximizes the potential for direct and indirect ecological benefits to multiple injured species and lost services. This may also benefit non-injured resources. The Integrated Approach would also create or acquire the equivalent of the injured natural resources and services if restoration efforts within the Bay or Basin are insufficient or not socially, economically, or ecological viable, or if time delays of other restoration actions warrant short-term measures to benefit resources and services.

Criteria 2: Provides an Alternative
The Integrated Approach provides a clear alternative for those species which will not recover without efforts beyond regulatory requirements for source control, sediment cleanup, and habitat restoration.

Criteria 3: Potential for Environmental Impacts
The Habitat Function Alternative is the core of the Integrated Approach Alternative. In addition to the typical actions that could occur under the Habitat Function Alternative, specific components from the Species-Specific Alternative could include modifying the substrate at locations in the Bay where appropriate habitat and water quality conditions exist to make it more conducive to shellfish and demersal fish needs, use of seasonal net pens for salmonids, and erecting nest boxes and perches.

In addition, components from the acquisition of Equivalent Natural Resources and Services Alternative are also part of the Integrated Approach Alternative. These components include improving ecological services to the Bay and Basin through habitat protection; by providing a diversity of habitat types and food chain support; facilitating cultural services such as subsistence, harvest and ceremonial practices; purchasing property for preservation; creating off-channel rearing ponds in conjunction with existing hatcheries; and creating habitats away from known discharge sites to provide equivalent natural resources and services within the region for fish and wildlife production.

Water and Sediment Quality. In general, this alternative should improve water and sediment quality in the Bay and Basin. The specific actions that could be implemented may have potential for short-term adverse effects on local water and sediment quality (e.g., placing net pens, excavating, dredging, placing instream structures, and other construction activities involved in habitat function restoration). Some actions should improve existing conditions for injured fish and wildlife (e.g., restoring wetlands to trap and filter sediments, restoring natural channel geometry, stabilizing and fencing stream banks, planting riparian buffers, removing culverts).

While some adverse environmental effects could occur if this alternative were implemented, the net result of the integrated approach would be restoring injured natural resources and services, as well as restoring the structural and functional attributes of ecosystems at the landscape level thereby reducing the cumulative or aggregate anthropogenic stresses to the

the study area, and thus depend upon the system for food and reproduction (Eaton and Dinnel, 1993). These habitat functions would not be restored under this alternative.

Some species of resident and migratory birds in the Commencement Bay study area could be further impacted by this alternative. Predatory birds such as the red-tailed hawk and osprey could be affected negatively by loss of feeding, perching, and nesting habitat.

It is also reasonable to speculate that increases of hatchery fish could supply more of a prey base for piscivores thereby reducing the risks of predation to non-hatchery fish. A larger prey base of hatchery fish could also be considered a benefit to piscivorous species (fish, birds, humans).

Threatened and Endangered Species. This alternative would not directly negatively affect any threatened or endangered species. However, it must be pointed out that leaving the existing contamination in place would continue to contribute to a contaminated food web resulting in continued suppression of wildlife populations in the area.

Criteria 4: Cost Effectiveness
This alternative could be cost effective in instances where the costs of trying to restore injured natural resources or services are too prohibitive in the judgement of the Trustees. The cost effectiveness of this alternative could vary dramatically, depending on the types of actions undertaken. The examples cited for species-specific restoration provide estimated costs for artificial enhancement measures (Section 4.2.3).

Criteria 5: Probability of Success .
The probability of success of this alternative varies from resource to resource and service to service. The emphasis of this alternative is on replacement of natural resources or services, rather than on restoration of injured species or habitat functions, which tends to be more difficult to achieve. This alternative could be used temporarily to shift some species toward baseline levels pending success of other restoration actions.

Criteria 6: Reduces fragmentation of Landscape
This alternative has low potential for reducing fragmentation of the landscape because it is oriented toward replacement of natural resources and services, rather than restoration of habitats.

2.5 Integrated Approach Alternative

The Integrated Approach Alternative is primarily based on the habitat function alternative, as well as specific components from the species-specific and acquisition of equivalent natural resources and services alternatives that will assist with (1) interim restoration of injured resources while habitat restoration is developing into a fully functioning system, and (2) recovery of those resources that require additional measures to achieve restoration.

ecosystem to tolerant levels (Cairns, 1993). The potential for additional impact to natural resources or services is low under the Integrated Approach Alternative. The flexibility under this alternative to integrate natural recovery, species-specific restoration, habitat function restoration, and acquisition of equivalent natural resources or services should avoid or minimize the potential for additional consequences.

Some adverse environmental effects that could occur under the other alternatives could also potentially occur under the Integrated Approach Alternative, since it integrates their best elements. Detailed environmental effects cannot be predicted at this stage since effects would be project-specific. Those effects would be evaluated in the next tier of the CB/NRDA process as site-specific projects are proposed. Nevertheless, a list of generic environmental effects that could occur includes: short-term noise and air pollution resulting from construction activities (e.g., clearing, grubbing, earth moving, dredging, sediment and soil storage and transport, digging, grading, burning, and planting; or construction of bridges or other structures); short-term water quality impacts (e.g., increased sedimentation and turbidity); temporary disruption of animal migrations, breeding, nesting; short- and long-term disturbance of existing plant communities; temporary disturbance of ecological processes such as detrital export and primary production; long-term disturbance of animal and plant communities; and increased probability of long-term competition, predation, and genetic interactions.

Fish and Wildlife. Conditions for the non-anadromous species that occur in the study area could be improved under this alternative. This alternative could result in decreased incidence of histopathological disorders in anadromous and demersal fish, as well as shellfish, and decreased concentrations of body burdens of contaminants.

Resident and migratory birds in the Commencement Bay study area could also benefit under this alternative. Predatory birds such as the peregrine falcon, osprey, and bald eagle would benefit from improved habitat and prey resource conditions. Improvement in habitat conditions could occur for upland species such as wrens, thrushes, vireos and owls that exist or existed in the region (Appendix A).

Increases in hatchery fish could supply more of a prey base for piscivores thereby reducing the risks of predation to non-hatchery fish. A larger prey base of hatchery fish could also be considered a benefit to piscivorous species (fish, birds, and humans).

Threatened and Endangered Species. Peregrine falcon, bald eagle, marbled murrelet, and White River spring chinook salmon should benefit under this alternative, which could result in increased prey resources and nesting and feeding habitat for avifauna and increased feeding and rearing areas for spring chinook salmon. Improved water flows would benefit adult spring chinook salmon, as well as juvenile salmon.

<u>Criteria 4: Cost Effectiveness</u>
The potential benefits of implementing this alternative can outweigh the costs. While the short-term costs of this approach may be high, Cairns (1993) suggested that restoration as

an integrated activity is typically cost-effective in the long-term. The Integrated Approach Alternative would use adaptive management techniques to apply knowledge gained from restoration projects to refine existing projects and to plan subsequent restoration projects, including use of new, more cost-effective techniques as they become available.

Actual cost estimates are difficult to provide for this alternative at the programmatic level, because of the range of potential restoration actions. Rough estimates can be obtained by using the costs associated with the other alternatives and piecing together certain restoration actions.

The 3.9 hectare (approximately 10 acres) Gog-le-hi-te wetland complex in the lower Puyallup River is an example of an integrated approach to restoration within the study area. This project combined multiple restoration actions, including siting of the project in a location which would allow fish and wildlife access; restoring natural hydrology; constructing tidal channels; breaching a dike; restoring an emergent marsh to provide feeding and rearing habitat for juvenile salmon, and feeding, rearing and nesting habitat for waterfowl and shorebirds; and planting a riparian buffer around the perimeter of the restored emergent marsh for wildlife. Design and construction of the Gog-le-hi-te wetland complex, not including monitoring, maintenance, or interpretive signs, cost an estimated $2.2 million (1985 dollars); approximately $500,000 of this total was spent on cleanup of barrels containing PCBs, which were unearthed during excavation of the emergent marsh.

<u>Criteria 5: Probability of Success</u>
The probability of success is high for the Integrated Approach Alternative, because the goal of this alternative is to maximize the opportunities for restoring, replacing, rehabilitating or acquiring natural resources and services injured as a result of the release of hazardous substances or discharges of oil, by integrating the best elements of the other four alternatives. This alternative affords the Trustees with the greatest number of restoration options and techniques to meet their statutory objectives. This alternative also is the most likely to result in diverse, functioning habitats that are environmentally and economically sustainable over the long-term, and support multiple injured species.

<u>Criteria 6: Reduces Fragmentation of Landscape</u>
The Integrated Approach is the alternative best suited for reducing fragmentation of the landscape. Shabman (1993) pointed out that existing habitats in urban areas are often an accident of the development process and do not necessarily bear any relationship to the optimal configuration of those habitats within the landscape. Thus, one of the primary objectives of the integrated approach would be to restore degraded habitats so that they are integrated into the larger landscape to ensure greater long-term NRDA restoration success.

3.0 COMPARISON OF ALTERNATIVES

This section summarizes the assessment and comparison of the five alternatives according to the six evaluation criteria, and identifies the alternatives to be carried forward for detailed analysis in the RP/EIS.

Table 3.4-1 in section 3.4 of the RP/EIS summarizes the discussions of each alternatives presented above, and ranks each alternative (high, moderate, or low), according to its ability to satisfy each evaluation criteria. The environmental impacts for each alternative were summarized under evaluation criteria 1. Environmental impacts are likely to occur under every alternative, but most impacts are very difficult to predict at the programmatic level. In general, the Species-Specific Alternative and Acquisition of Equivalent Natural Resources and Services Alternative have moderate potential for short- or long-term environmental impacts if implemented. The other alternatives should have fewer and shorter-term impacts on the environment (i.e., they are ranked as low-moderate).

The No Action Alternative should have no direct adverse impacts, since no new actions are implemented under this alternative to improve water or sediment quality, habitat conditions, fish and wildlife, or threatened and endangered species. Indirect impacts could result if this alternative fails to result in improvements to existing conditions and habitats continue to be degraded, or if habitats, which could otherwise have been restored under one of the other alternatives, are converted to industrial, commercial, or residential uses. The No Action Alternative is by far the least costly and must be brought forward to meet NEPA requirements. The alternative has a low probability of success in terms of NRDA restoration goals, but could easily be implemented immediately without any direct adverse effects to the environment.

The Species-Specific Alternative has moderate potential for short-term impacts to water and sediment quality, habitat conditions, and fish and wildlife species. Long-term adverse impacts to water and sediment quality could result from construction of new hatcheries, net pens, or aquaculture facilities.

Release of hatchery or net pen fish could increase competition, predation, and genetic interactions with wild anadromous and resident fish species. Although the Species-Specific Alternative is perhaps the best suited of the five alternatives to restoration of individual injured species, it is not likely to satisfy restoration goals 2 and 3 (providing benefits to more than one injured species and providing an alternative for species that will not recover without efforts beyond regulatory requirements) as well as several of the other alternatives. This alternative has a low potential of reducing fragmentation of the landscape and does not achieve landscape ecology goals as well as several of the other alternatives and so does not satisfy the first objective of the CB/NRDA program.

The Acquisition of Equivalent Natural Resources and Services Alternative could result in short-term decreases in water and sediment quality, and increased damage to specific habitats. Specific fish and wildlife resources would benefit from this alternative, but these species would be substitutes for the injured resources and services. This alternative is one of the best for providing an alternative for those resources that will not recover without efforts beyond regulatory requirements. However, as a stand-alone alternative, acquisition could only be implemented as a last resort in those cases where restoration of the injured resource or service is technically infeasible or the cost is too prohibitive in the judgement of the Trustees. This alternative has a low potential of reducing fragmentation of the landscape and does not achieve landscape ecology goals as well as several of the other alternatives and so does not satisfy the first objective of the CB/NRDA program.

The Habitat Function Alternative should result in net improvement in water and sediment quality over the long-term. In addition, this alternative is specifically designed to improve habitats that function in support of multiple fish and wildlife resources. Some habitat restoration actions could result in short-term impacts, but these impacts can typically be avoided or minimized. The Habitat Function Alternative is one of the best at achieving landscape ecology goals and satisfying the first objective of the CB/NRDA program.

The Integrated Approach Alternative has low to moderate potential for short-term impacts to water and sediment quality, habitat conditions, and fish and wildlife species. Adverse impacts could result from the use of net pens; however, proper siting and the use of seasonal delayed release of net pens under this alternative should not result in any reduction in water and sediment quality. Release of hatchery or net pen fish could increase competition, predation, and genetic interactions with wild anadromous and resident fish species. Proper timing in the release of hatchery fish should greatly reduce competition with native populations. Construction of off-channel rearing habitats, in conjunction with hatcheries, should increase the size of juveniles and thus reduce competition in nearshore environments as juveniles move farther offshore.

Because of the higher potential for environmental impacts under the Species-Specific and Acquisition of Equivalent Natural Resources and Services Alternatives, and the inability to satisfy the stated goals and first objective of the NRDA restoration program, these alternatives will not be carried forward for full evaluation in the RP/EIS. They have been eliminated as stand-alone alternatives but, as indicated in Section 3.3.5 of the RP/EIS, some action items of these two alternatives are advanced and contained within the Integrated Approach Alternative. The No Action, Habitat Function and Integrated Approach Alternatives are carried forward for full analysis of the environmental consequences in section 4.0 of the RP/EIS.